Declaration in accordance with 37 CFR 1.132

I, the undersigned Yitzhak Nevo (Ph.D), a citizen of Israel residing in Ein Harod Meuhad, Israel, hereby declare a follows:

1. I received my Ph.D. degree in physics from the University of Tel Aviv in 1978. Between the years of 1982 and 2003 I worked in Rafael - Armament Development Authority LTD. (which is the Applicant of the present application), Hereinafter, "Rafael". My work involved a substantial research and development in the field of electro-optics, and particularly development of optical systems. During the year 1990 I had a one year sabbatical during which worked in the Royal Observatory, Edinburgh, GB. During the year of 1999 I had another one year sabbatical during which I worked in Telic Optics, Inc, Massachusetts, US.

2. In 2003 I retired from Rafael, and established my own consultancy firm. Since then, among other issues, I substantially dealt with the research and development of optical systems. My major expertise is the analysis of various optical systems to evaluate their maximal detection range. Among others, I developed software for determining the maximal detection range and the possibility of recognizing objects by various optical systems under various atmospheric conditions.

3. Among others, I have published the following articles that are relevant to the present issue:

   a. "*Optical Design and testing of fast, large aperture, infrared space telescope*", C.M. Humphries, Y. Nevo, E. Atad, and J. W. Harris, Space Science Reviews 61,211 (1992);
   b. "*Use of Diffractive elements to improve IR optical systems*" Y. Nevo, D. Nir, S. Wachtel. SPIE vol. 4820 (2003); and
   c. I am also a co-invnetor if U.S Patent 5,113,281 entitled "*Dual field of view optical system*", D. Mandelbaum, I. Maom, and Y. Nevo 1992).

4. My CV is attached to this declaration.

5. I have no interest in the outcome of the present US Patent Application Serial number 10/597,642, nor in the product which is the subject matter of said application.

6. I was requested by the applicants of the present invention to review the documents regarding the US Patent Application Serial number 10/597,642. Specifically I have reviewed the application, including the set of claims as now amended, the Office Action mailed on May 5, 2011, and the prior art cited by the Examiner in the Office Action – Kaman (US 5,231,401) and Pepin (US 6,320,611).

7. In view of my professional experience and CV, I consider myself a qualified person for the evaluation of the Examiner's objections

in light of the cited prior art, and specifically I consider myself a qualified person for the purpose of consideration of the validity of the rejections of the claims, as made in the Office Action.

8. Claim 1 as now amended reads,

An airborne long-range laser imaging system, for obtaining an image showing high resolution details of a specific object having dimensions in the order of several meters, <u>and which is located at a distance above 10Km.</u> comprising:

A. A laser source and focal plan array sensing detector, both being mounted on a same gimbals platform;

B. A pulse generator for providing a series of pulses to said laser source during a step-scanning period, thereby activating laser illumination by said laser source during each of said pulses, the laser source being characterized in that the width of the illumination beam is in the range of 0.1mrad to 0.4mrad so that it produces an illumination spot that covers only a portion of said object having dimensions of up to several meters and located at a long range <u>of above 10Km;</u>

C. A scanning unit for receiving a line of sight direction to said object, and for providing to the gimbals a scanning signal for effecting a stepping-image capturing sequence in such a manner as to scan the object and the area in which said object is included, wherein said area having dimensions in the order of up to a few tens of meters;

D. A motion compensation unit for providing to said gimbals, in addition to said scanning signal a motion compensation signal for compensating for the aircraft motion and for the aircraft vibrations;

E. A timing unit for:

i. Activating, in coordination with the said scanning unit, said pulse generator during the scanning period, in order to produce over the target a plurality of illumination spots, each relating to one of said laser pulses, and wherein each of said spots overlaps at least a portion of one or more adjacent spots; and

ii. Activating in a non-gated manner said focal plan array sensing detector during the illumination of the target by each specific pulse in order to capture a plurality of distinct spot-images, each relating to a single illumination pulse;

F. A memory unit for receiving from said focal plan array sensing detector the captured spot-images, and for storing them;

G. A correlating unit for correlating images stored in said memory by finding similarity between features of overlapping portions of neighboring spot-images; and

H. *A combining unit receiving information from said correlating unit for combining the spot-images to form a complete image of the scanned area.*

9. I have noticed that claim 1, as now amended, relates to "*an airborne long-range laser imaging system, for obtaining an image showing high-resolution details of a specific object having dimensions in the order of several meters,* ***and which is located at a distance above 10Km,*** ***...***". It is well known in the art of laser systems that obtaining an image, and more specifically, detection of such a small object from such a long range of above 10Km is extremely challenging. I am well aware of many tries in the art to increase the detection range of laser systems and to fulfill such a task, however, with very little success. In such prior art systems, the obtained images from the object have been of very low quality, if at all possible. There are several problems that prohibit fulfilling of this task, as follows:

   a. The signal attenuation, signal to noise ratio, size of the object and the long range: There is a limitation to the power of the laser source at the aircraft, and obviously, there is a very large attenuation of the laser signal until reaching such a long range (of more than 10Km), hitting the object (having the size of several meters) and returning back to the aircraft sensor. Clearly, only some photons reach and hit the small object at such a long range, and very few of the laser photons can arrive back the aircraft sensor. In order to overcome this obstacle, many prior art systems that I am aware of have increased the power of the laser source at the aircraft up to huge power levels. However, there are clearly many drawbacks involved in applying such a

huge laser power level in an airborne platform. Moreover, even though such a high power of the laser source was applied, the results have been very limited in terms of the quality of the object's image. In this respect, I refer to "Johnson Criteria". Johnson's Criteria define the minimum required resolution of a target which is located within background scenery, in order to be detected by an observer. According to these criteria, the farther the location of the target is, a higher resolution is required in order for an observer to detect it. Moreover, the higher said required target resolution is, a higher contrast between the target and the background scenery is required.

b. The problem of motion compensation and vibrations of the airborne platform: On top of all the above problems (of small object, very long range of above 10Km, very low level of signal to noise ratio, limitations in respect to the laser power, etc.), the airborne platform is typically in movement (and therefore motion compensation is required), and it also suffers from significant vibrations. Therefore, the very low signal to noise ratio due to operation at the end of the laser effective range (i.e., very few photons hit the target and reach back the aircraft sensor), in addition to the inevitable movement and vibrations of the aircraft, introduce an additional very significant factor of quality descent in the system with respect to the object's image.

10. In order to overcome the above mentioned problems, several solutions have been proposed by the prior art:

a. Increase of the power of the laser source: As mentioned above, even though the power level has been increased to huge power levels, still the prior art systems have failed to provide satisfactory images of targets beyond a range of about 10Km.

b. Extension of the duration of the laser pulse: Various prior art systems that I know of have tried to extend the duration of the laser pulse, therefore to obtain more returned photons at the aircraft sensor. However, this can be done only to a certain degree, as increase of the pulse duration beyond some level results in a significant smear of the object.

11. There is one "asset" that the prior art systems have always kept: All the solutions of the prior art that I am aware of have been so designed to apply illumination over the object that extends **beyond** the borders of the object. More specifically, the prior art systems have included a laser illumination source that results with an illumination spot at the object location (i.e., at the very long range, close to the end of the laser range) having a size always larger than the expected object size. This was done in all the prior art systems in order to always keep the most important asset, i.e., to keep all the external borders (i.e., the contour) of the object within the single image, as the contrast between object and its background scenery is the highest at those external borders and therefore those borders are the most prominent within the scenery. The prior art assumed that operation in such a manner will provide best quality of images within the abovementioned constraints of very low signal to noise ratio.

12. Simple trigonometry can show that in order to provide an illumination spot having a size larger than the expected object

size (i.e., several meters of diameter) at the end of the laser source range (e.g., above 10Km), the width of the illumination beam must be in the order of 1-3 milliradians (of course the width of the laser beam also depends on the exact expected range and on the amount of background scenery that is desired to be included within the image). For example, let's assume a tank having a dimension of 10 meters is located 10,000 meters away from the laser source. In order to have an illumination spot which is larger than 10m of diameter at the object location, the illumination beam has to have a width of:

$$\alpha \geq \tan^{-1}\frac{10}{10000} \geq 0.9 \mathit{millirad}$$

In order to capture the whole object in a single image, while also including some of the scenery within the image, the prior art systems that I am aware of have typically used 1-3 milliradians for the width of the illumination beam in order to include the entire object within a single image which is captured.

13. Therefore, my opinion is that the inventors of the present invention went away from the teaching of the prior art, by giving up the asset that the prior art systems have considered as the most important asset to keep. More specifically, I found that claim 1 suggests a significant reduction to the width of the illumination beam to about 0.1-0.4 milliradians. By doing so, the

inventors of the present application gave up the belief that an object at such a long range cannot be detected, unless <u>all</u> the borders of the object are included (together with at least some portion of the background scenery) within a single image. The approach that I found in the present application is clearly against the teaching of the prior art. By reducing the illumination beam to about 0.1-0.4 milliradians, the inventors of the present application have obtained a more concentrated beam that can reach a longer range compared to the prior art. The "loss" of the object borders within the single image has been compensated by the combination of the other elements of claim 1.

14. I have found that Kaman et al. does not specifically indicate the range of his laser detection system, however, when discussing the need for a high signal to noise ratio, he in fact suggests two solutions:

(a) <u>Increase of the illumination output power by use of an additional amplifier</u>: This solution is proposed by Kaman, for example in col. 6, lines 36-41, as follows:

> *This laser system is augmented <u>by the addition of a second amplifier</u> 142 <u>which increases the output power</u> approximately 50 percent. The use of a second amplifier 142 in each transmitter is an important feature of this invention and has the advantage of providing increased power with good mechanical, volumetric and weight efficiency.*

(b) Use of multiple laser sources: This solution is proposed by Kaman, for example in col. 5, lines 31-37, as follows:

A pair of lasers 60 and 62 are driven by laser power supply 54 so that short (approximately 10 ns) pulses of visible light are generated. (It will be appreciated that the present invention may utilize only a single laser transmitter; however, multiple lasers are preferred for increased power as will be discussed in detail hereinafter).

And also in col. 5, lines 31-37, as follows

Images from these cameras can be averaged to improve SNR and enhance the operator's ability to classify the target.

It is my understanding that both of said two solutions of Kaman suggest the transmission of much higher power in order to improve the signal to noise ratio. However, based on my experience, when dealing with a high range above 10 Km (see claim 1), these solutions are not really applicable in an airborne platform, as they require use of a huge power level in the laser source, or a multiple number of laser sources (that also consume huge amount of power), that are impossible to carry and synchronize, situations that the invention tries to avoid.

In any case, there is no doubt that the width of the illumination beam of Kaman is many orders larger than the width of the beam of the present invention. While present claim 1 suggests an illumination beam of 0.1mrad to 0.4mrad, Kaman suggests illumination beams in the order of several degrees. The example of Col. 8, lines 30-41 suggests 3 variations for the half width of the laser beam (namely A182=3.8°, A188=2.505°, and A184=3.079°). Inspection of Fig. 11 confirms that this width is in fact half of the width of the beam. Therefore, even in his most concentrated version of the beam, Kaman clearly suggests a beam width of 5.01° (i.e., 0.087 radians) which is 217 times larger than the largest beam width (0.4 mrad) of claim 1 (or about 870 times larger than the narrowest beam width of 0.1

mrad of claim 1). Therefore, it is my understanding that Kaman's system is clearly designed for a short range (up to several hundreds of meters), and is inapplicable for the recognition of an object having a dimension in the order of several meters at a long range above 10 km, as in the present invention, unless an increase of the power of 217^2 or 870^2 is provided compared to the solution of the present invention (as the illumination power at the target squarely depends on the width of the beam). The fact that Kaman suggests such a huge increase of the beam width (even many times beyond the 1-3 mradians beam width which is conventional for such a range as admitted by the present application) shows that Kaman clearly teaches away from the present invention.

In any case, I have found that Fig. 1 of Kaman clearly shows that the illumination spot of Kaman covers an area which is <u>many times</u> larger than the expected size of the target 20. More specifically, each image (whether obtained by one camera, or plurality of cameras) of Kaman contains <u>at least</u> the entire expected target in it, and in fact the image covers an area much larger than the target. Kaman never suggests the possibility in which the width of the illumination beam "... *produces an illumination spot that covers <u>only a portion of said object</u> having dimensions of up to several meters and located at a long range <u>of above 10Km</u>*" as in claim 1 of the invention. It is my understanding that the Examiner is accurate in stating that the system of Kaman "*scan[s] a relatively narrow IFOV over a much larger field of regard*". However, I have found no teaching in Kaman to the fact that the width of the laser beam is designed to form an illumination spot which is <u>smaller</u> than the outline (contour) of the target. It is my understanding that the Examiner interpretation that "*... the width of the beam is a design parameter to resolve the image at a desired distance...*" may be accurate when dealing with conventional ranges as long as the width covers the entire target, but when increasing the range to above 10Km, the suggestion of claim 1 of the present invention is in fact against the teaching of the prior art, as it suggests giving up of the outline borders

of the target. As previously noted, and based on my experience, the conventional prior art systems for such a range of above 10 Km typically use a width of 1-3 milliradians for the illumination beam (excluding Kaman that as said teaches an illumination beam which is hundreds of times wider than of the invention) in order to maintain the contour lines of the entire object within a single image, and in order to meet the requirements of Johnson's criteria (mentioned above), that state that the contrast of the object at the contour lines is the highest. In contrary, I have found that the present invention teach away from this approach, resulting in a much narrower illumination beam of 0.1 to 0.4 milliradians giving up these contour lines for the purpose of significantly increasing the range, while still obtaining a clear image of the target.

15. US 6,320,611 (Pepin) I have also found that although the system of Pepin relates to "optronic equipment", there is no mention whatsoever of a laser beam in Pepin. Therefore, my opinion is that Pepin cannot recover the deficiencies of Kaman, and that a combination of Kaman and Pepin cannot lead to the present invention as in claim 1.

16. **Conclusion**

In view of my above, I conclude that claim 1 is not obvious in view of Kaman and/or Pepin, even when the teachings of these publications are combined (if at all they can be combined).

17. I hereby declare that all statements made herein are of my own knowledge are true, and that all statements made herein on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or

imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the subject application or any patent issuing thereon.

18. The name and signature below are my name and signature.

Yitzhak Nevo

Yitzhak Nevo (Ph.D.)
This day of October 27, 2011

RESUME

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JOB OBJECTIVES

To work in one of the following fields:
1. Research in optics and/or optical design.
2. Optical design and analysis of electro - optical systems.
3. Optical design and analysis of astronomical instrumantation.
4. Applications of diffractive optics.
5. Research and development of electro - optical systems.

EDUCATION

Study period	Name and address of school	Subject	Degree	Award date
1963 - 1966	Hebrew University Jerusalem	Physics	B.Sc	1966
1966 - 1968	Hebrew University Jerusalem	Physics	M.Sc	1968
1972 - 1977	Tel - Aviv University	Astrophysics	Ph.D	1978

M.Sc Thesis title : Isentropic models of neutron stars.
Name of superviser: Prof. Gideon Rakavi

Ph.D Thesis title : A search for optical pulsations from compact objects (white dwarfs, neutron stars, black holes).
Name of superviser: Prof. Dror Sadeh

ACADEMIC and PROFESSIONAL EXPERIENCE

Period	Name of institute	Department	Rank
1966 - 1972	Regional High School		Teacher
1972 - 1979	Tel - Aviv University	Physics & Astronomy	Instructor & Researcher
1982 - present	Armament Development Authority (RAFAEL)	Electro - Optics	Research Physicist
1990 - 1991	Royal Observatory Edinburgh	Applied physics group	Researcher on Sabbatical leave

From 1982 experience and activities as follows:

- Various optical designs for thermal imaging systems, CCD sensors, observation systems including zoom systems.

- Wide knowledge and long experience in working with CODE V (optical design and analysis software package) and ASAP (stray light analysis package).

- Analysis of electro - optical systems performance (including software development).

- Combining diffractive optical elements in optical systems.

PUBLICATIONS

1. On the optical stability of X-Persei.
   A. Frohlich and I. Nevo
   Mon. Not. R. astr. Soc. 167,221 (1974)
2. Search for optical pulsars at the sites of two radio pulsars and two supernovae remnants.
   I. Nevo, D. Sadeh and A. Frohlich
   Astron. & Astrophys. 36, 311 (1974)
3. A search for optical pulsations from single line spectroscopic binaries.
   I. Nevo, D. Sadeh and A. Frohlich
   Astron. & Astrophys. 42, 247 (1975)
4. Oscillations in KT Persei during two outbursts.
   I. Nevo and D. Sadeh
   Mon. Not. R. astr. Soc. 177, 167 (1976)
5. A search for oscillations in 11 dwarf novae during their outbursts.
   I. Nevo and D. Sadeh
   Mon. Not. R. astr. Soc. 182, 595 (1978)
6. A search for nebulosity around Sirius.
   N. Brosch and I. Nevo

7. Dual field of view optical system.
   D. Mandelboum, I. Marom and Y. Nevo
   United State Patent No. 5113281 (1992)
8. Optical design and testing of a fast, large aperture, infrared space telescope.
   C.M. Humphries, Y. Nevo, B. Atad and J.W. Harris
   Space Science Reviews 61, 211 (1992)
9. Third order classification of three-mirror optics.
   Y. Nevo
   Royal Observatory Edinburgh internal publication (1991)
10. Wavefront analysis of centrally obscured pupils.
    Y. Nevo
    ROE internal publication (1991)
11. The occultation of 28 Sgr by Titan.
    Many coauthors.
    Astron. & Astrophys. 269, 541 (1993)
12. Author and coauthor of about 20 classified internal reports related to different optical items, optical designs and electro-optical systems analysis.

PERSONAL

Citizenship : Israeli
Born : DEC 13 1935 in Haifa Israel
Marital Status: Married, Two children.

REFEREES

1. Dr. Eliezer Rosenblum, Head of optical group, P.O.B 2250, Haifa 31021, Israel.
2. Dr. Gavriel Catalan, Senior optical designer, P.O.B 2250, Haifa 31021, Israel.

REFERENCES

Available upon request.